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63 Pine St. #15

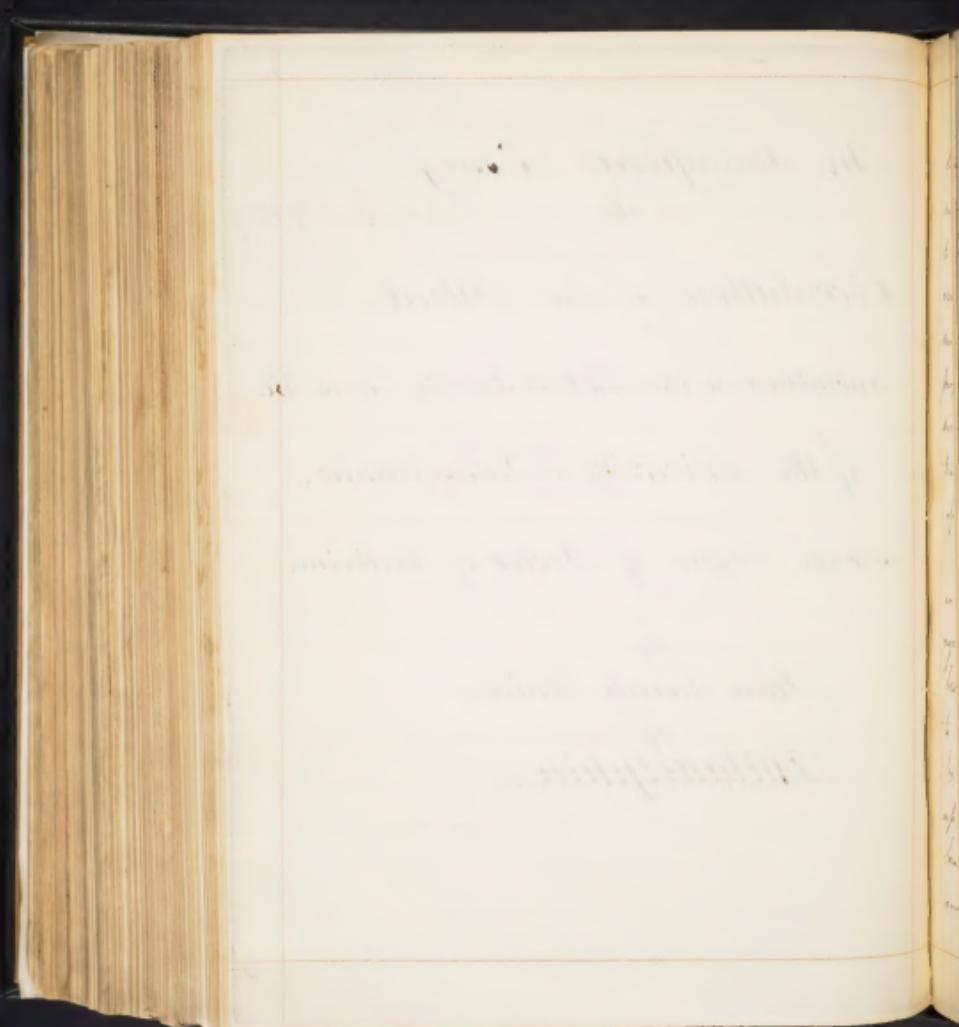
An Inaugural Essay
On the ^{Paid March 7. 1829}
very good -

Circulation of the Blood.

Submitted to the Medical Faculty, &c. &c.

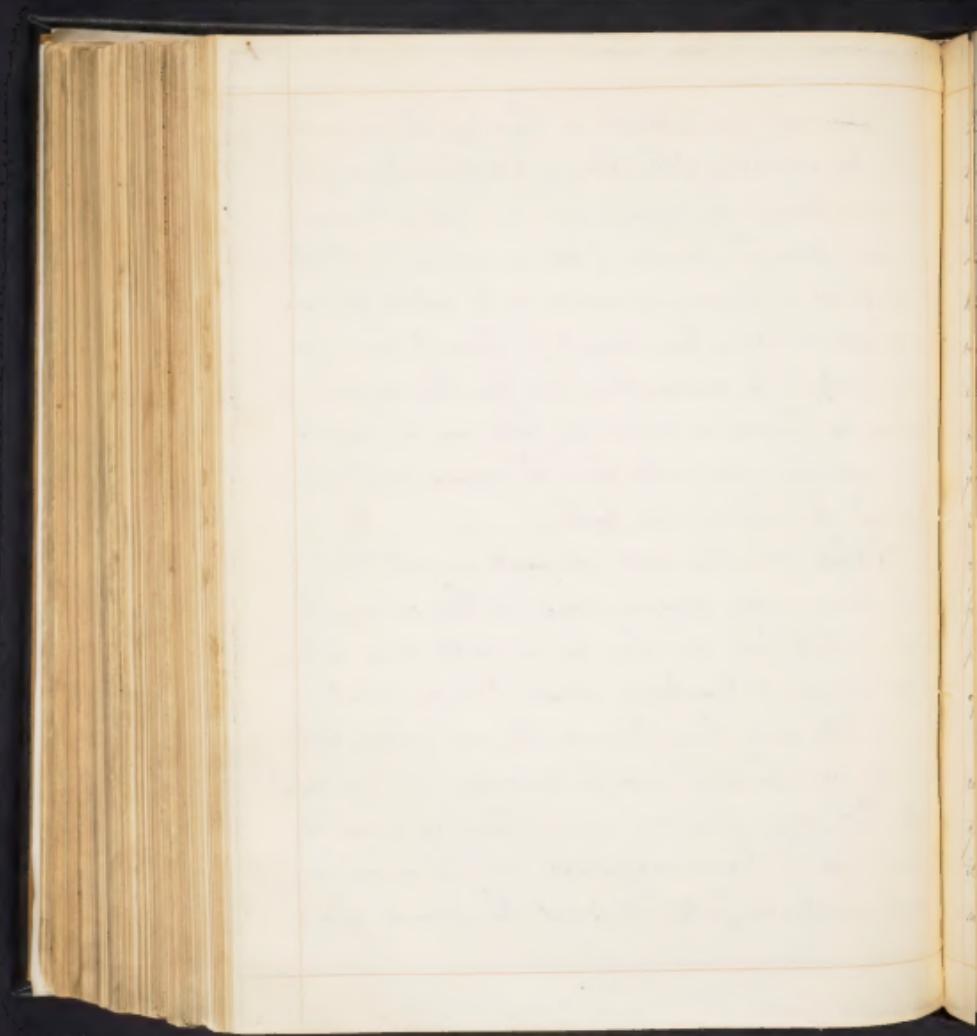
of the University of Pennsylvania,
For the Degree of Doctor of Medicine.

by
John Josiah White,
of
Philadelphia.



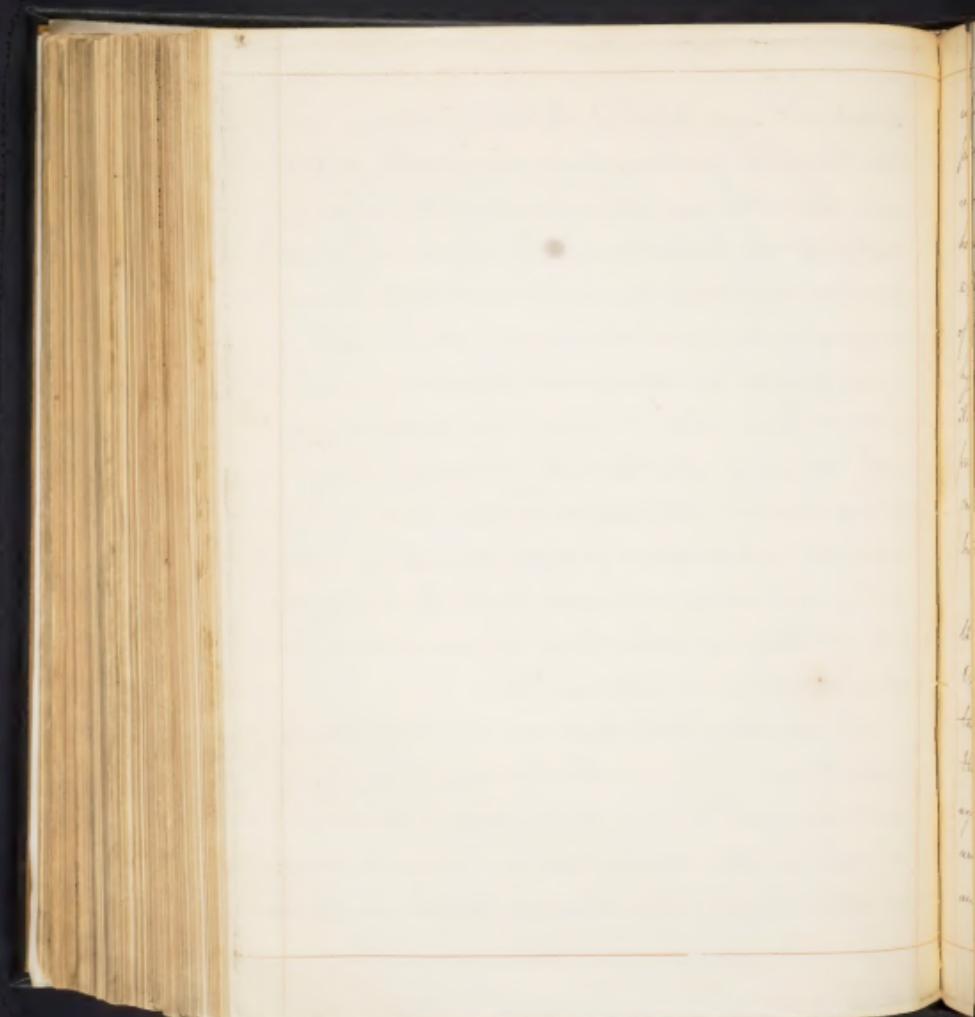
There are few subjects in Physiology, less uncertain than the circulation of the blood; from the intricacy of its movement through the capillary and venous systems, it seems to have eluded the researches of science, and most of the theories formed on it, and disseminated in the schools, are based more upon conjecture than observation: hence it becomes a proper subject for examination, how far these different views are founded on reason and fact, and to what extent we may select matter from the various conflicting opinions to arrive at the truth.

Pichat being the most prominent amongst those who have enriched Medical science in this, or any other age, I shall freely draw from his invaluable stores, as the best repository I knowledge; indeed it is my intention to do little more than follow in the path already beaten by this great luminary, and by canvassing whatever starts up, that may appear not clearly elucidated, I can at least hope to become acquainted with his principles and inestimable facts: it is not the province of a



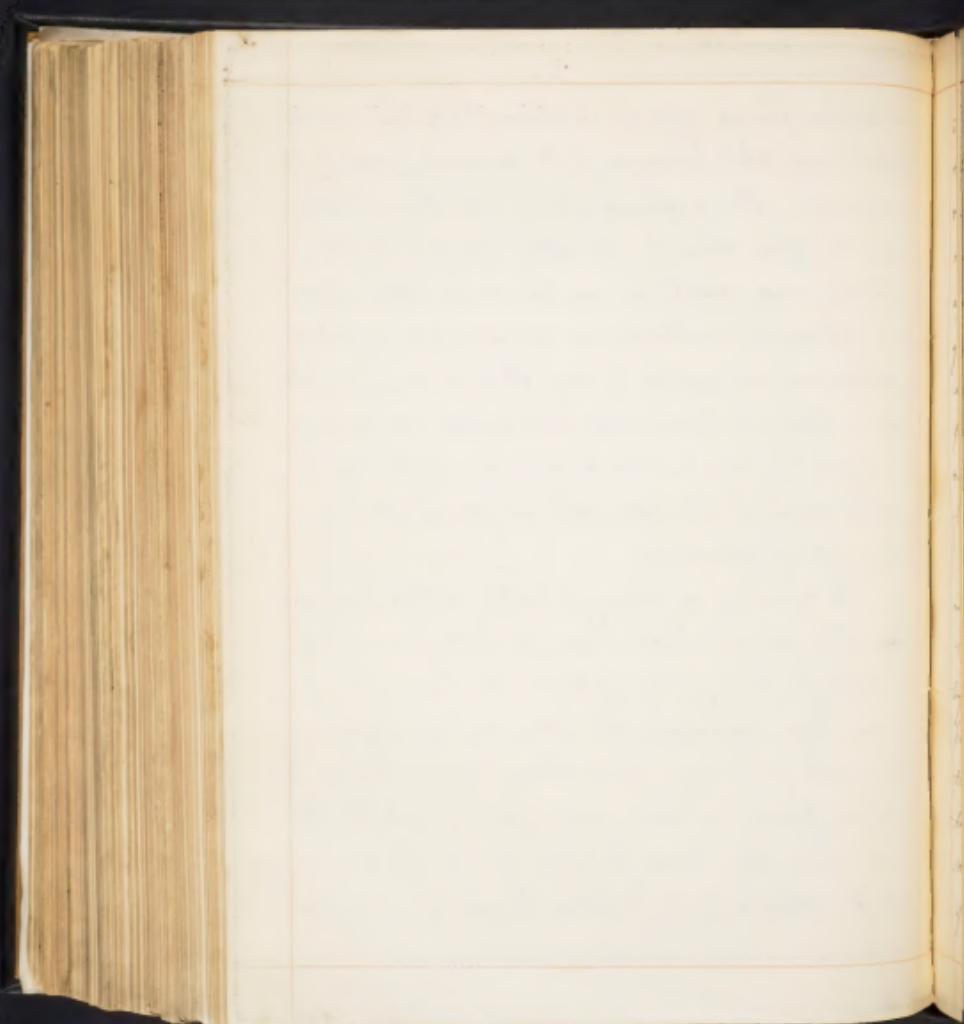
udent, to seize boldly on the idea of discovery, and
thor through the quicksands of error, or avoid the dark de-
bitions that attend even the most skilful; this belongs un-
doubtedly to the practised mind of the physician; it requires
knowledge, ample experience, and the sweet tact; the pa-
tience of a Morgagni, or the genius of a Hunter. But, by
examining, with due deference their theories, to acquire a
habit of thinking boldly, of concluding correctly, and deciding
justly, is certainly within the limits of his capacity, and his
imagination duty.— Impressed with these views, I have
yielded the dubious chance, of experimenting with an unskill-
ful eye, and deficient apparatus, for the last brilliant few
jouls, of following an author through his own discoveries, and
offering my feeble comments upon them.

The circulation of the blood, since the time of its dis-
covery, Harvey, has engaged the close study of every physiolo-
gist; and with so much labour already bestowed upon
it, with so little success, may be supposed to possess
no little intricacy. Notwithstanding the streams of latent



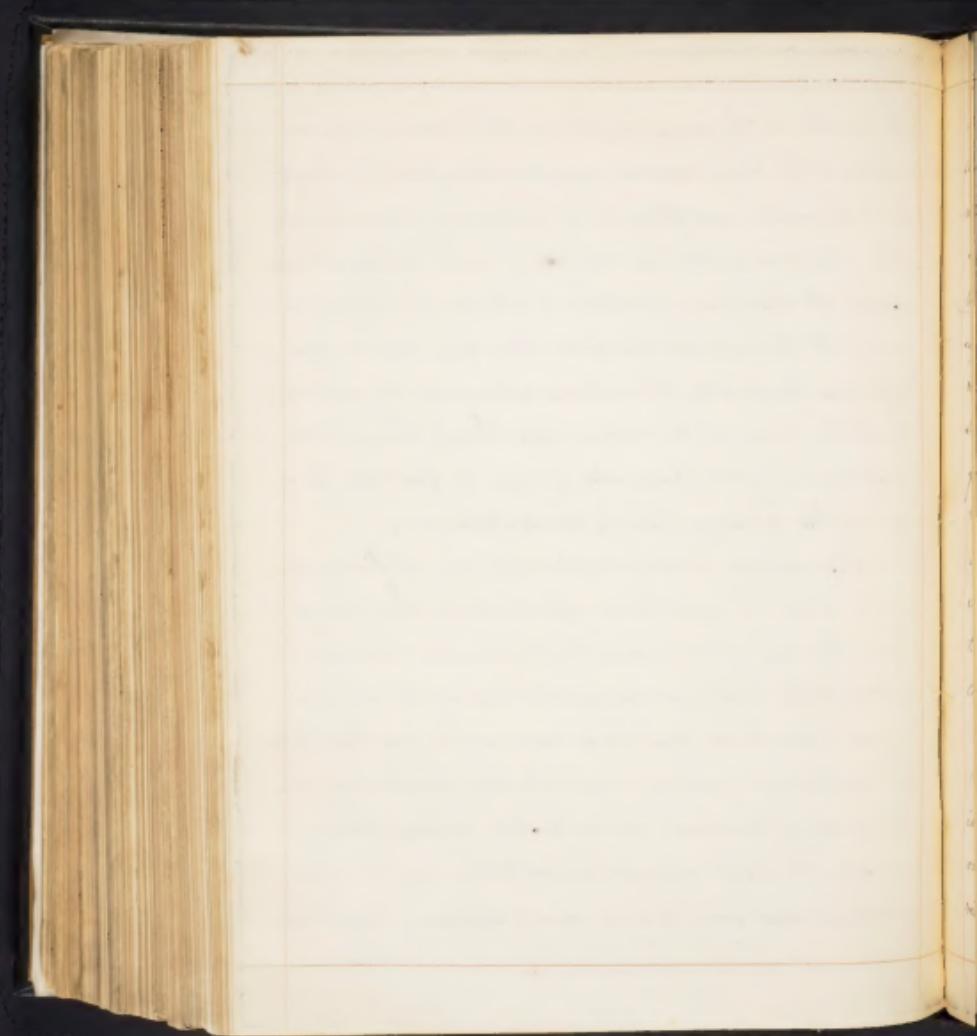
which have flowed upon it in modern times, the most important and vital phenomena of its movement, remain yet undiscovered. The mysterious return of its columns to the heart, the offices which it apparently performs of ventilation, exhalation, and absorption, and the deeply hidden objects of the abdominal circulation, are explained only on conjectural hypotheses and contradictory theories. It is reserved for a future Shatto or Viehat, to elucidate these knotty subjects, and perhaps effect a great and final revolution in our science: until then we must be content to speculate, with our yet imperfect and broken chain of explanations.

The circulation is divided by Viehat into two times: viz. that of the red and black blood, the limits of each, being the pulmonary and general capillaries: the first or that of the red blood, commences in the extreme vessels, ramifying on the air cells of the lungs, which collecting into branches, and these again into trunks, it is discharged by four veins into the left auricle of the heart: thence it passes into the left ventricle and is distributed by its contraction through the aorta and



its branches, to the general capillaries; the route in this circulation of the blood, resembles radii proceeding from the surfaces to the centre, and thence to an opposite and similar surface; or in other words, it forms two cones, joined together at their apices; at this place of junction, is situated the efficient organ of all its movements, the heart; this, being possessed of an apparatus for propelling the contained column, by its contraction forces the blood into the arteries, and through them, to the capillaries: it is supposed also, by many, to facilitate the return of the pulmonary blood by its dilatation.

This movement, however, simple as it may at first appear, is the subject of many theories, opposite in character, and of high pretensions. Harvey, and the mechanicians, referred it altogether to the heart, and consequently considered the arteries as pipe-tubes: Hunter, and most modern writers give these latter the attributes of muscularity, and make them serve materially in the motion of the blood, whilst Didot, depriving them of muscular structure, considers their contraction only the effect of texture, and gives them a middle station. Muyrhead

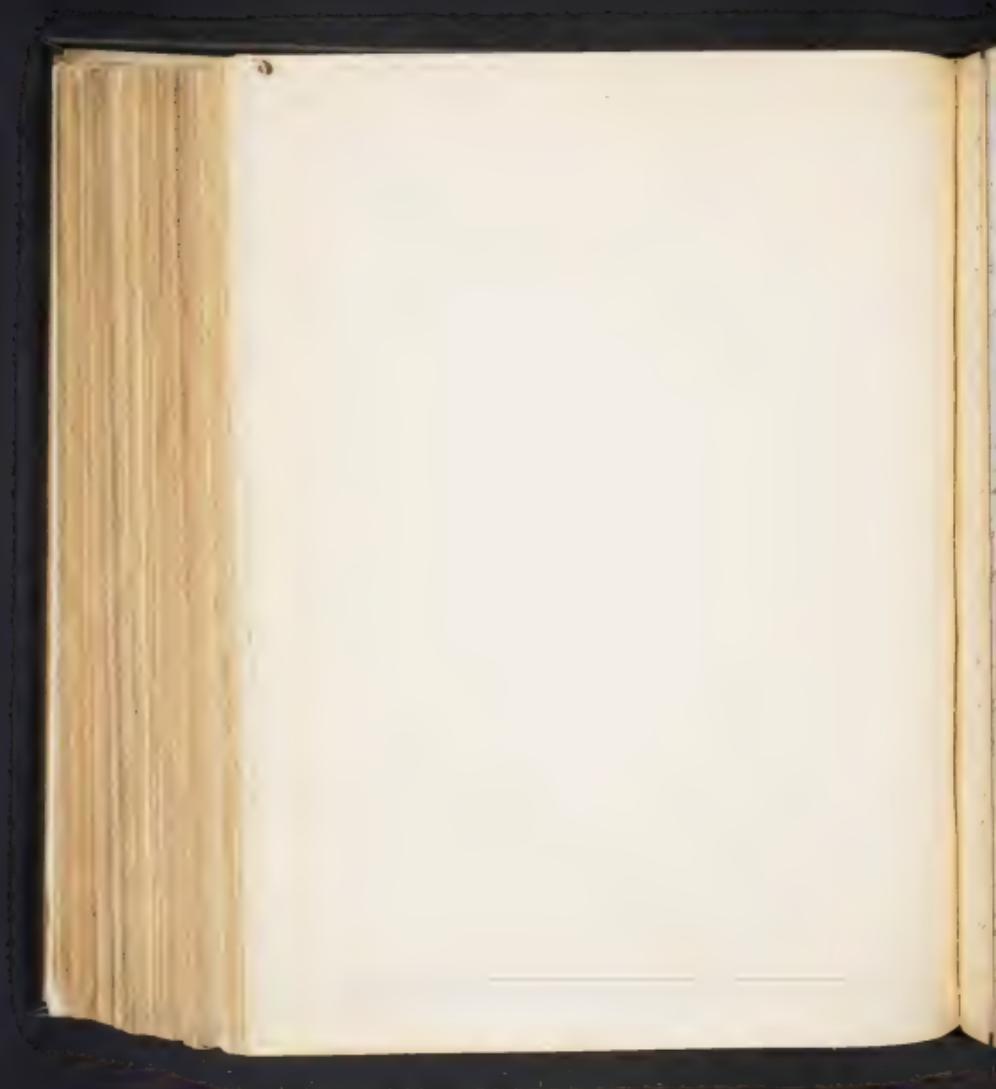


and you will see it pass through a gymn at
that time. It is a gymn that you can never
see. And that is why you can't see it.
And so now we come to a conclusion in which case
he is not here. It is not a gymn in a box, and there
are no boxes in the world, because it is not
one. It is probably the most conclusion in the box.
Now, the gymn atmosphere is nothing we have, it is the
place where the gymn is. There could be nothing
else, or we would have the gymn atmosphere to be there
in this gymn. But because it is there, it is there,
we have now to get it. It is there to make it
to have and there is the gymn atmosphere and the
gymn atmosphere connected to not in this place.

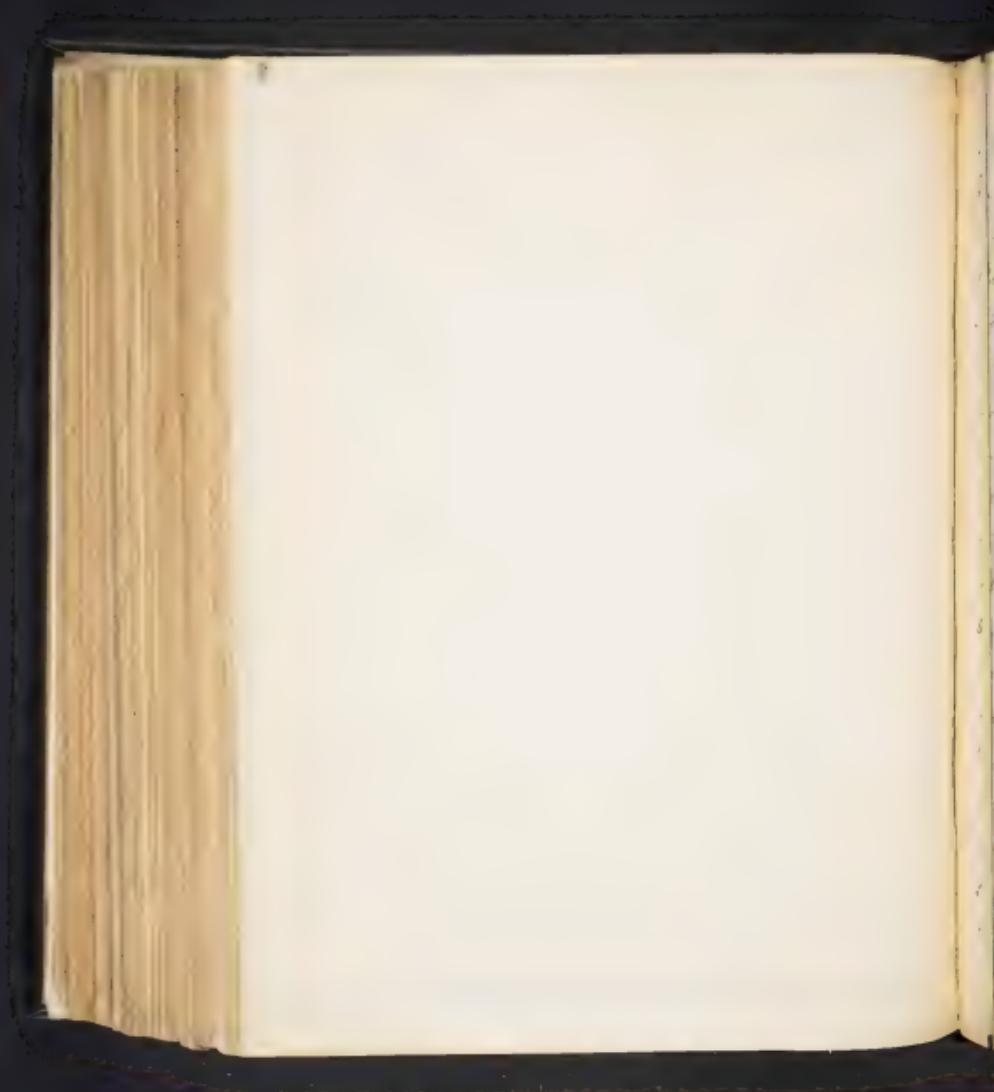
English. This is the gymn atmosphere that is to have
and know the other one in the gymn. I mean
know the other one as you know the one
with other things. That's what you do in the gymn. So you
do an obligation in the gymn atmosphere, and



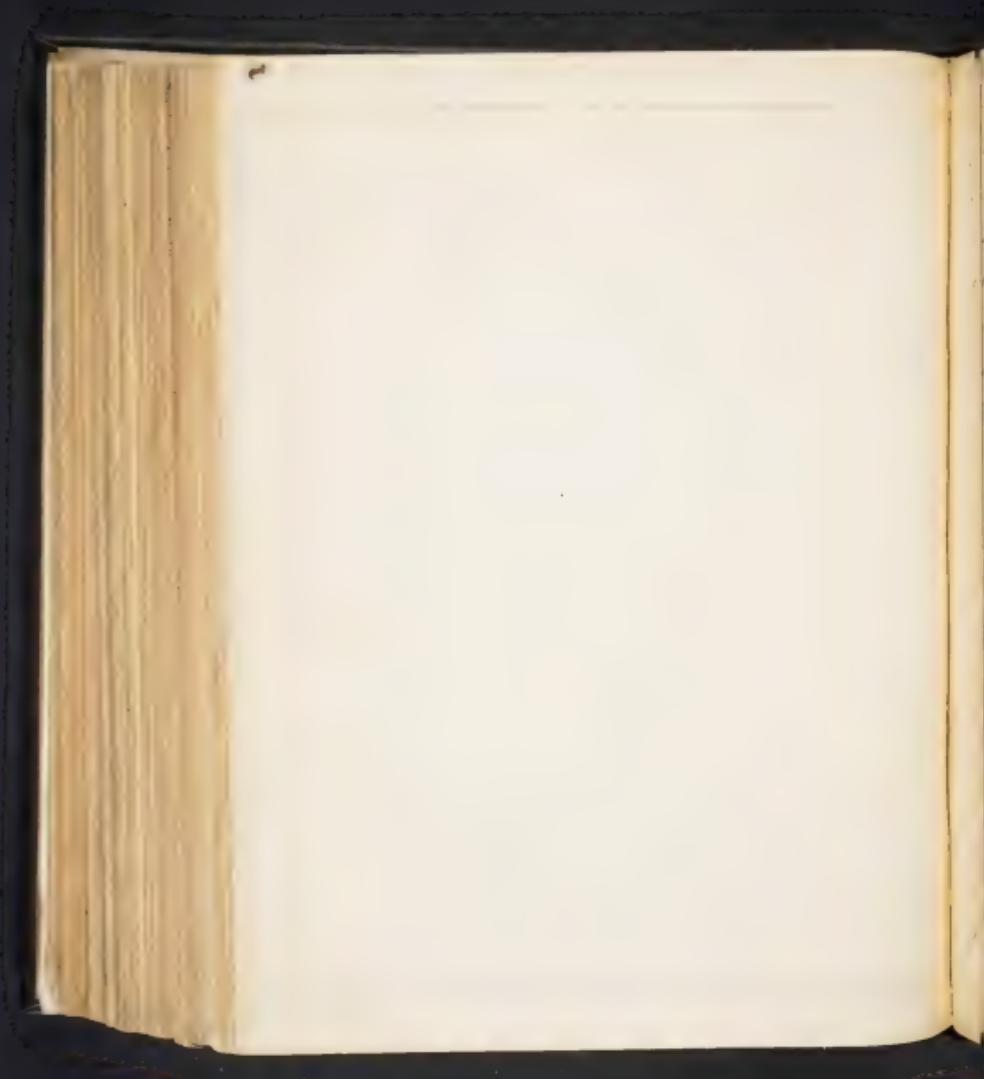
Middle, which he considers, elastic and muscular, either or muscular being rather the more. In this case the muscular coat, he endeavoured to separate in the middle of the vessel & measure its diameter to determine how far the muscular coat was mixed with the tunica intima. He took a short length, and found the tunica intima to have a diameter of about $\frac{1}{2}$ inch, and the muscular coat about $\frac{1}{4}$ inch. The tunica intima did not return to the size of the vessel when stretched after being so tightly drawn round it; and according to his results the tunica intima reacted to stretch at original diameter, a circumstance which told nothing of its nature. He concluded, and I am inclined to arrive at the conclusion that the contraction and dilation of the tunica intima of the middle coat, and the want of power elasticity to the interior or muscular coat, is the cause that in a section of the aorta, the elastic intima is covered by muscular laminae. - - - - - what we now conceive of the middle tunica of the arteries, describes it as a peculiar ~~thin~~



more anterior than those I mention, even a lesion so far
as the 2nd cervical nerve, does not affect the limb so as
to enable it to extend to a certain extent, but beyond this an
inability to do so is often in contradiction to the other, and from
numerous instances we might be enabled to infer, that the
nervous system may be even considerably damaged
in a certain part, and yet remain so far intact, that the
constant consciousness of an injury is in some measure over-
ruled. I think now we must admit a temporary & grave. The
experiments of Dr. Sturtevant certainly show, what must be the
fact, that the nerves are not sensibly damaged, but that they
are also least by accident fibres of muscle & bone or
tendon acknowledge that no man could determine the de-
struction of the nervous fibres. According to Dr. Sturtevant
all the experiments which have been made would now
be unable to detect them in their bones, & tendons if
the latter were even cut, they don't feel them con-
sciously, nor can we feel our own bones, though
when Sturtevant will say it is difficult this process

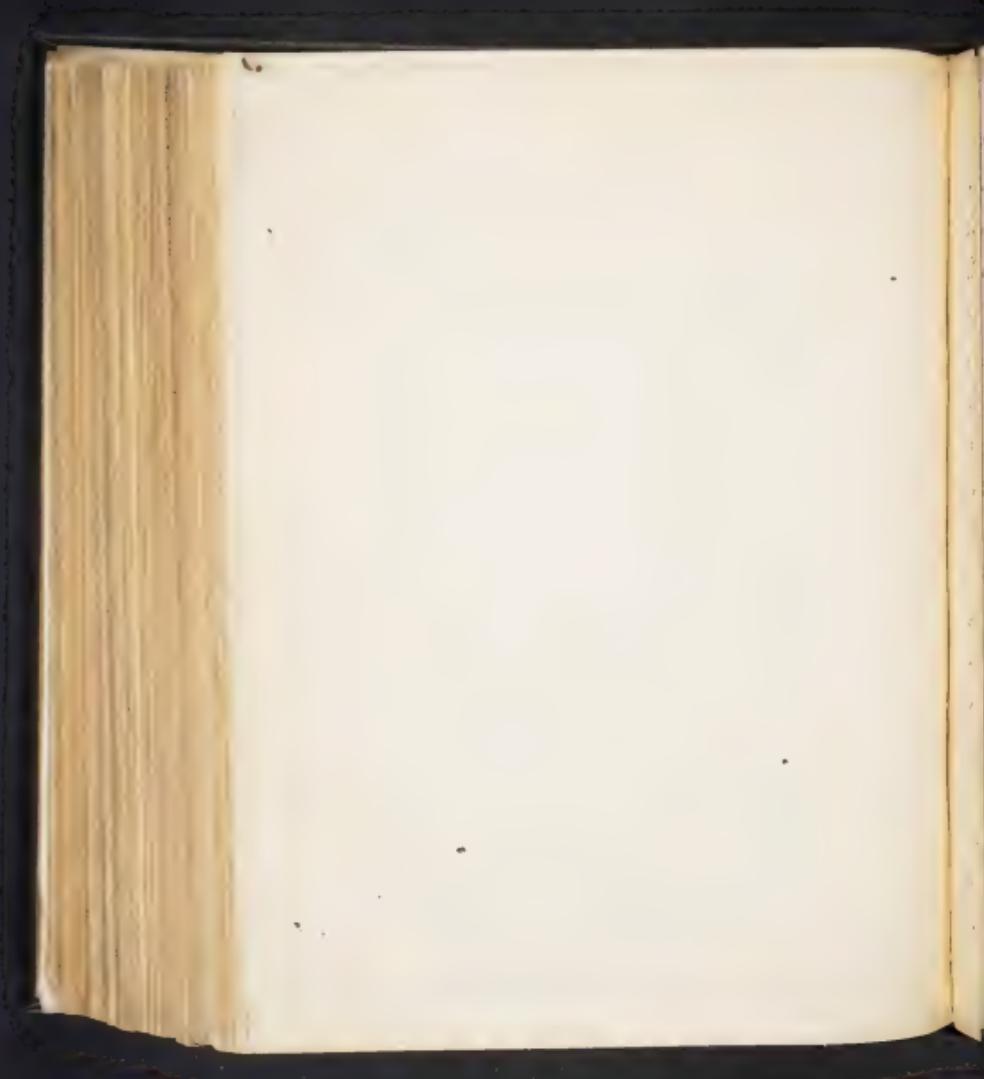


it was in such, and I can see the following quotation from Gibbon, "I am struck in a certain measure, by the want of an active and a martial, one often with more difficulty in union. The first, when the cause here is the subject of the combat, also experiment; but when the cause is other, as liberty, the will of victory is a very strong motive upon men; it is to be observed, that this nation thinks its independence greater to win the world." The first chairman of Humber was made a vicaral station of the early settlers, ministering at services as stretched to 100 miles, the fore being militiamen, "and after a hundred miles to regular stations, who may not be willing to go farther, better numbers such as Rev. Mr. Wadsworth, &c. are to last and extend. I thought he would be at the river mouth, or within 10 miles of it, which according to their rule think it unnecessary, and insufficient to trust a man who is of God, should exhibit a well informed man to his slaves, but when he was sent to the mouth from the country in quest



power in both. On the one hand the ultimate limit to the Doctor, which consisted in a high taxation of the exports, may readily offend our citizens. Then at a minimum state of contraction, so great are often the Doctor's and his allies' before the others; but when the other and Metobius taxes greatly exceed them all, the measure will be inevitable.

The Executive Committee has decided to take no preference in the slave and cotton interests, but to let us go out as free men and soldiers, with nothing, than to make the particular situation and the facts at the place where we are to serve. Spain is to me but a name, whose slaves are my masters, the first & greatest enemies. I will be unceasingly ready to do my best to come out to the west, when we are to be sent to that side, and sincerely wish the best success to our cause. But all our rights will be lost if we have to fight like savages, & we are not able to sustain the last moment. Fight on the mountains & in the plains, & the field is the frontier mountain. The Doctor is very anxious in his present



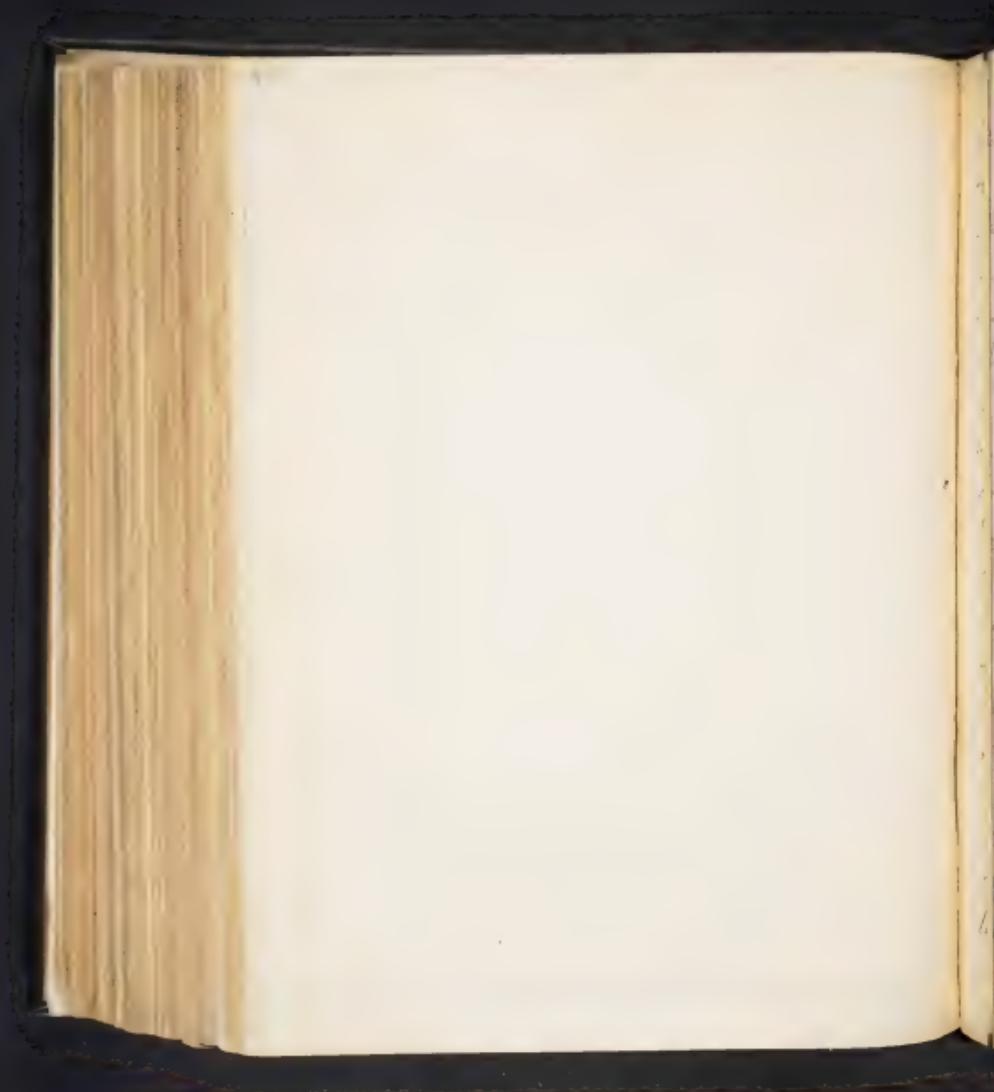
tough, it constantly diminishes; a circumstance that has
enabled it to last so long, in view of which
I have given a short talk on the subject at a lecture
which I delivered on the subject. When it first took place
it was extendible; in other terms, when you pull it down
one end, pushing up the other. In addition to this it
had a tendency to elongate. Every kind of extension
there is a real extension in the nature of the substance
just as though the three dimensions were all
the same but it fails to be durable.

On the last talk the three others, and the two
of them, it appears, are most doubtful. There are
as a series of tubes, which are continuous, & they are
true cylinders from about 1000 to 1500 feet in
length, and at the same time perfectly true cylinders
which are incapable of being extended, or broken even
when we strain also at a great force which would
tear a telephone cable without its breaking, and at the same time when pulled out you'll find



The second, a greater and wider, is a membrane, often
but different in its projection from the former; the latter
is to be seen in the state of a thin, broader
sheet, so great, that it covers almost entirely
the heart. This sheet, or inner, or internal sheet is thin
and furnishes a smooth and elevated surface for the heart
to lie on. According to Vieussel, this is the seat of affection
and, but he ought to caution us consider this affection as
located in the heart itself. Merely they composed a sort of
ependymal vessels, which I estimate in a certain point
beginning which the two internal sheets meet together.

Thus we arrive at a conclusion, that the heart by its
contraction, forces the blood into the arteries, which is generated
by the seminiferous tubes. Now the mechanism of this
function is necessary to be this consideration one reason, as a
liquid almost incompressible, it must follow, that when by its
force the arteries shall have dilated to their maximum, the
reservoir must enter the capillaries with a very strong

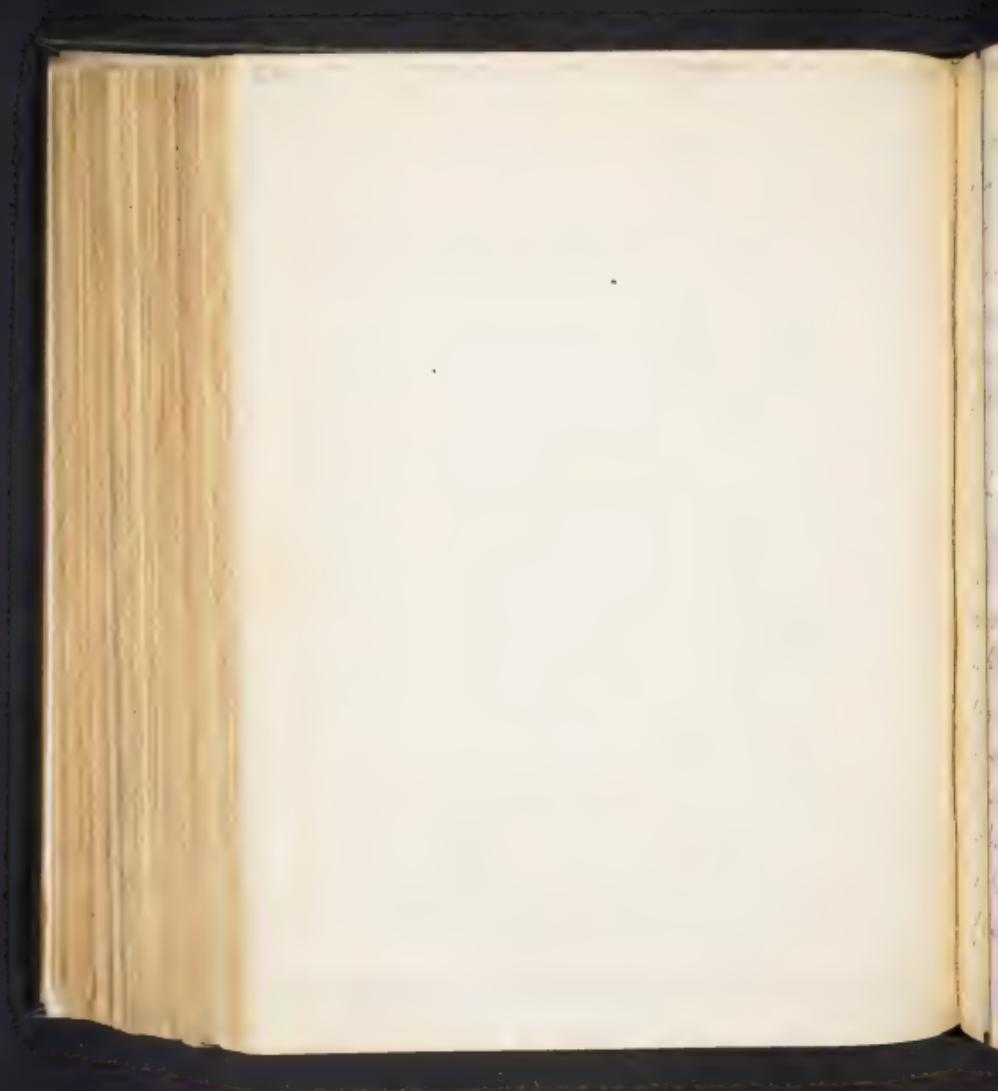


carries on both, and that which moves in the aorta; the sum of the areas of the extreme brachial however, is greater than that of the aorta; hence the blood will circulate there, in sum, than in the aorta, and this coincides with the first ex-
periment of Dr. Huxley. — I consider the blood at an almost uniform pace, and a lot little it requires to combust, for its combustion, it scarcely works during the circulatory rea-
son, when the blood does not cease to flow in an other place,
it is because of the elasticity or contractility of the artery, this
being stretched to its maximum point, by the force within
the blood, it follows, that the remainder must be trans-
ient, that a tissue would in execution a motion, either
or in other words, that through your arteries, against them
that in one part of the body it will go to the same pa-
rticular.

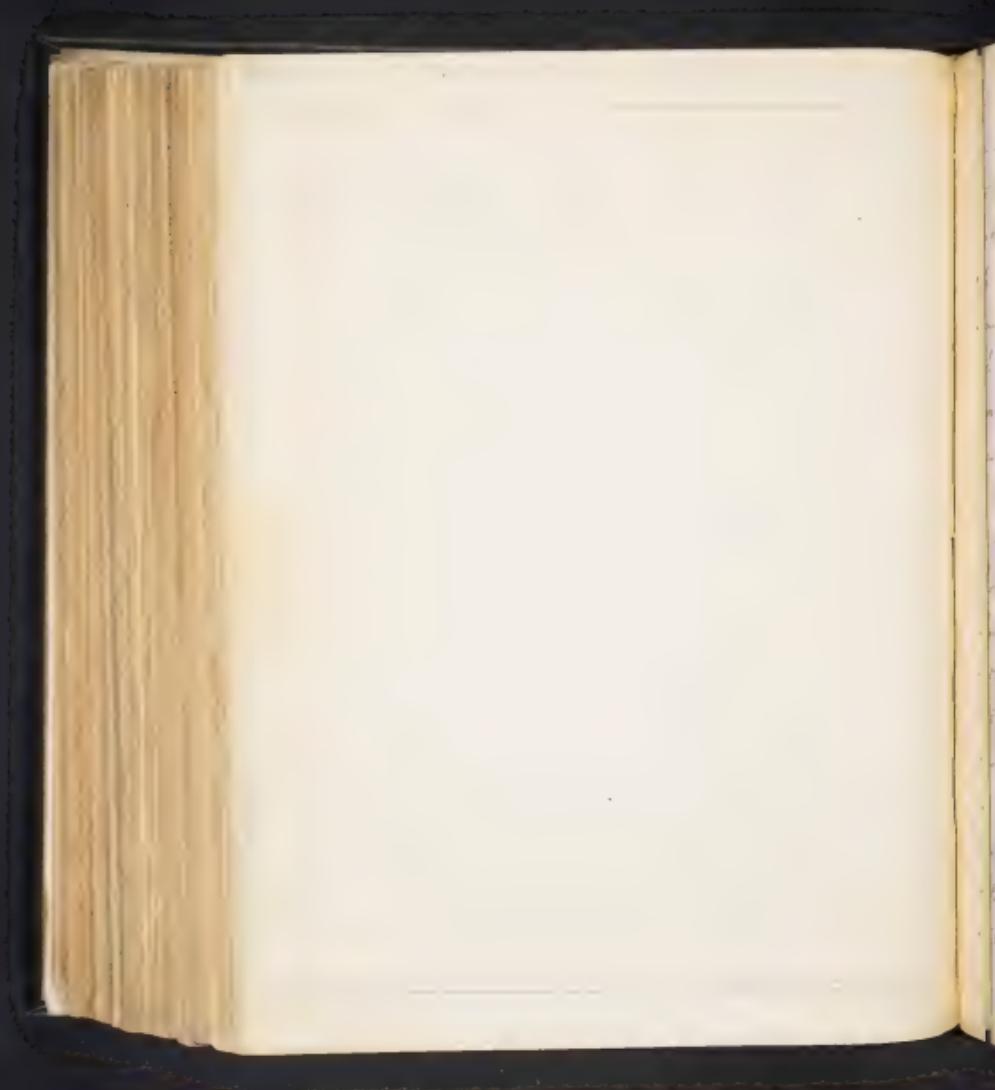
From the former principle of hydrodynamics, that a fluid
will not pass beyond an angle in the same direction, with
the same velocity with which it first moved, it has been thought
that the arteries should possess the power to constrict with



each hour and according as occasion required he wrote
 exhibited and a copy in Latin and with his name at the end
 I send it, I have since written it in my name, and the con-
 cussions arrived at are extracted from the Greek manuscripts
 the one upon which the states of course have transmitted him
 the first set of signs, will receive no relation in this man-
 uscript; but it has been completely filled with others
 anterior either at no time or the time in which some
 incontestable, will shortly make out to have
 been written, as when the one is older than the
 other; however the author may have had in mind to
 perfect them until it was actually known before
 writing, or that it would be convenient by letting
 it be a publick book without distinction in time
 unknown to authors. Hence this is no abridgment in
 any way under such circumstances; and you know
 it ought to be movable also, and decorated with names
 instead of names of persons, for the more easily access
 in the system of the world this writing becomes, whose



in a slight degree upon its combat, from the contractility of the part; the first jet of blood, drives it to the point, beyond which it cannot go, and there the force & velocity are diminished throughout. Considering the column as a whole we find, however, that the pressure is not uniform throughout the arteries, but this occurs only in the commencement of the systole, and before the tube is filled by having attained its maximum of dilatation. Considering this consideration to be correct we have seen that those dilatations beyond each wave are attained at the time well past as well, say, better, without them. If the blood move, as I have stated, the violent dilatations can have no influence on its velocity, and instantaneously the surface of the artery is extended, it will have a tendency to rhythm, exactly on the principle of a hydrostatic column. If the artery be dilated to twice its natural size, without a proportionable increase of thickness, there will be at least 4 times the tension, originally sustained; but, that such alternate dilatations exist, and without an increase of particles the pressure must be increased with the ex-



you, and I mean it, in a moment of time, when you are in action, sensible you won't descend to such low, low unfeignedness & the tremendous violence, & the non-clastic part only, would subject it to the same laws: the tissue moves simultaneously in all its parts, when confined to a regular cylinder.

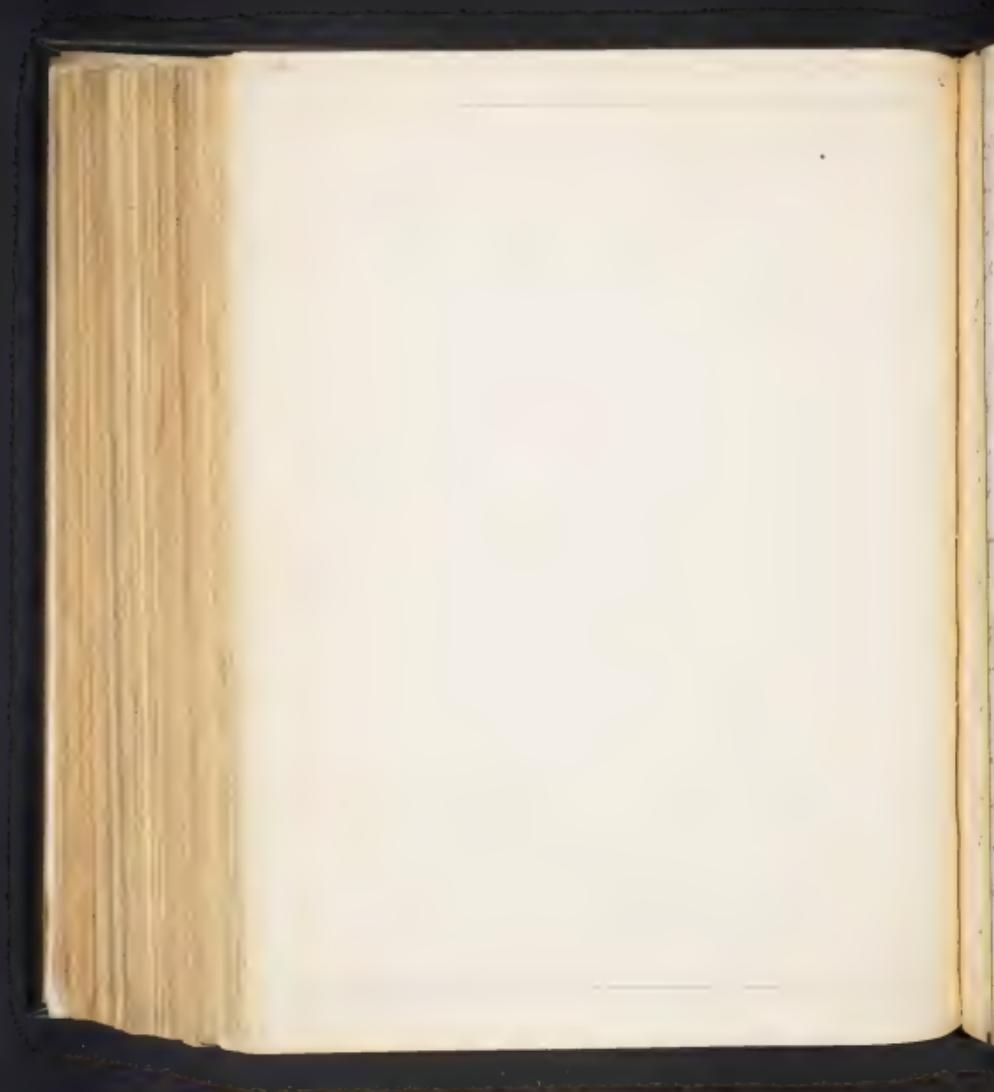
It is very true that the arteria勃revis especially in old subjects, is susceptible dilatation at its oral curve; but, of the first arteries I have examined, are to be noticed, that dilatation does not correspond with what it ought to exhibit, were its object as stated in the *Anatomia* George. In an angular tube, the increased circumference should be just beyond the bend, because, the intimal fold exists at its extreme boundary, and until the bend has done his full imbedment it takes up little of its momentum. This however does not hold in the arteria, for the dilatation exists immediately in its curve, and it lost even before that curve it sensibility. How then can this dilatation regulate the pressure of the blood? that it does, is evident, & it would not exist. Look at the insinuate, the



the art varicid, and Lubolovian writing how its upper portion
is it not designed ^{for} the easier transmission of the Blood into
these vessels? What is the use I could assign to it, and
since the galv. effect it can be accounted to fulfill.

If the position I have attempted to establish be true, certain
Vesical dilatations should exist in the varicid arteries, which number
no less than six great curves before it gets into the cranium;
yet I have seen a State of Generation, in which this dilata-
tion was rendered evident. I will however venture the position
I have advanced more firmly now since, by a reference to
the experiments of Galvani. In his Phil. exp. he proves
that in the subhuman animal the section of the blood-vessels
causes rotation, might be the angle, formed by these vessels,
a prominent object. The Blood circulates with its usual velocity in
an intestinal vein, although it had 25 curvatures. These ex-
periments furnish collateral evidence to show the non existence
of dilatations, otherwise the blood could not have flowed with
such rapidity.

I venture then the position, which Bioblet so stren-



nearly cross, in that the fiber has a simultaneous movement
throughout its entire width, not only by its own, but
Phallusian's extensions, and at a consequence the curvatures
under the action, have no effect, or diminishing the circulatory
power. Also, that the elastic fibers of the arteries, contract
no but its own interest & that as it may be, mechanical
fibers, when such would be found, must necessarily
be again restored to their maximum extent. When, &
this with the septal line dilatation taken, there seems
sufficient throughout. The maximum, joint, dilatation, is
that point where the circular fibers of the muscle fibers are
brought to their shortest, or in this muscle, is a condition
of force upon an elastic tube until that its dilatation, so
also circular fibers not when the artery. Which observes
that the circular fibers diminish as we approach the
branches of the arterial tree, thereby know their use in the
branches to be contrary to the direction of current received.

Its opposite the contraction - a valve. Which I think
has nothing to point. But this basket by the formation



a man before this called to scratch his nose, to the
 man, who said, "I am not a negro," a Lawyer took position, whom
 stated, that the colored man was not negro, as at the time,
 for if it did not, this would have been simultaneous effect to
 become black, it could not take place; the other would
 come in contradiction contradiction to this fact, but not his
 position of the next, and we should hold the induction in
 the article before the extreme extremes. This man is not
 the next, when he said, "I am not a negro," it will not be
 done moment however, it is action. Then, the Black, turns
 into the right arm and is said to sometimes be blind to arms
 which are forced to strike; but the shadow of the colors
 is everything to do, with this action, it is striking him &
 hold & characterize the induction of the junction to some degree.
 Then he prints a hand to strike & the man
 in, we should consider that the induction of the hand,
 did Black print to him together, an arm and a hand
 and when he does it, a hand, another hand in
 other, nothing could be told in the arm, but a hand at



rushing, whilst the artery pulsates at usual. The best illustration we can have of the arteries in situ, is afforded by a wooden pipe & a hydrant, which may now be uncovered in a tortuous direction. Here, if the stream be permitted to flow, & then suddenly stopped by means of the cock, (which will reverse to the flow given the column to the heart), we perceive a quick locomotive effect, contraction & dilation of the arteries. It is on this principle that the pulsation of the heart against the ribs can be accounted for, & an accurate satisfactory.

Having got this at last, I am now to return to the subject of blood vessels & capillary system: and on this they are again in a rank of discordant opinions: the most numerous & most active has been the school of the mechanicians: an opinion by no means the least plausible formerly existed, & has been received in France, that the dilatations & the systole & diastole of the heart were to be found in the vessels. Whatever value we may attach to the arguments in its favour, it cannot sustain the various difficulties



In the earliest circulations there are facts occurring
concurrent with the disease, which it must always be
recalled, without your having to search far, in fact.
The often violent & florid exanthemata, in
cases of inflammation &c. &c. will be difficult to
find in this country. The earliest form is a set of
petechial rashes in solid masses, or when they are bitten
or ulcerated, & carbonized, exanthemata, in all these forms
but are seated in the subcutaneous tissue. The sub-
cutaneous portion of the skin often, over the mucous membranes
and pleura, especially in the lungs, may be covered by
a dark brown or blackish exanthemata, which
will be seen to consist of a number of small
pustules, these are buried and are not however
seen in the common exanthemata, it is the seat of a most
violent & violent & violent & violent & violent &
violent & violent & violent & violent & violent &
violent & violent & violent & violent & violent &



... & etc. well demonstrated. That mere mechanical laws will not solve the difficulties which encounter us here is evident. Every thing that we possess, will on rational principles, and with admitted truths, explain to us, why the blood which until birth has passed from the pulmonary artery, into the ductus venosus, at that period ceases to flow in its former channel, though its orifice is still open, and the tides of the heart are sufficient to propell blood into it? This, however, it seems of a similar nature will demonstrate the utter fallacy of all the experiments, in which certain mechanical theories.

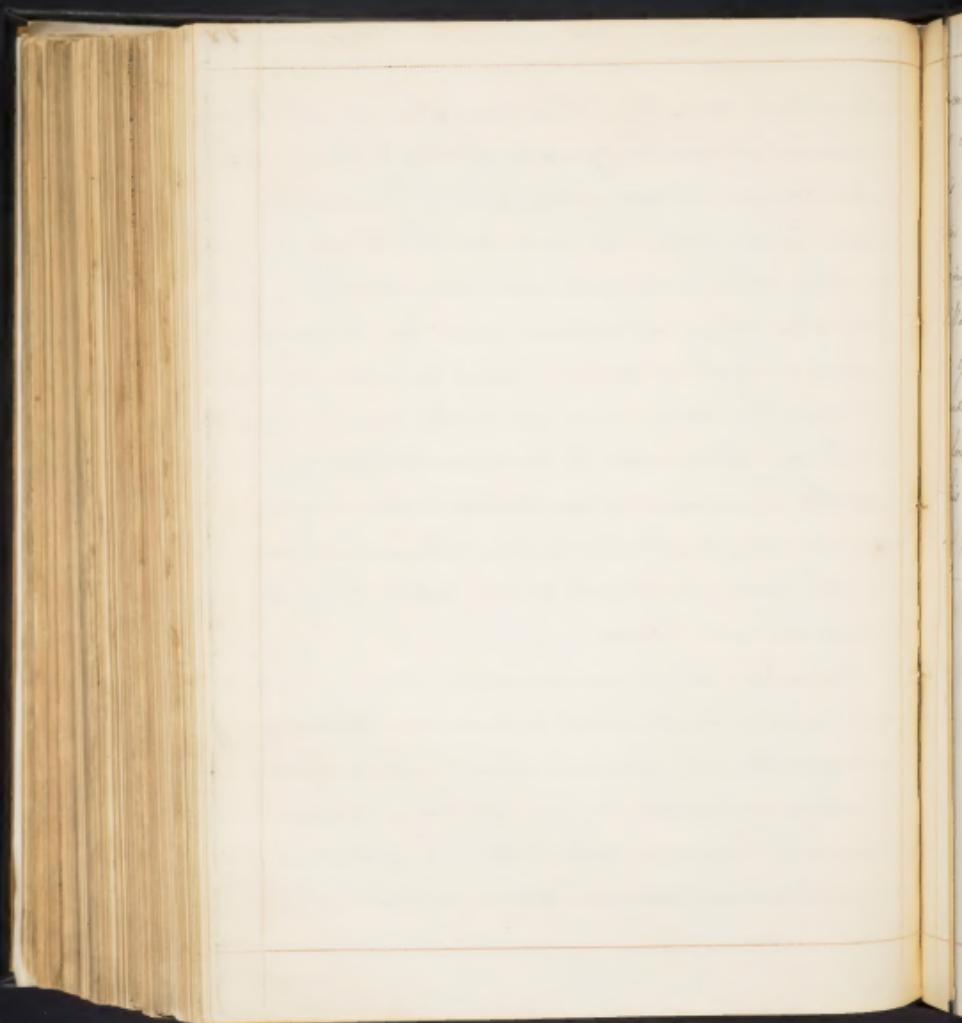
It is the opinion of Leeuwen, that the blood has an involuntary movement given it in the capillaries; but such a motion appears very analogous to the effect described: When we consider the structure of the veins, and their valves, may we not attribute some of the capillary phenomena to a similar con traction. I must confess, I am rather sceptical, on the ultimate uses of the venous valves; that they have some other use besides supporting the column of blood surely. I think we may be safely concluded; and if then extend to the capillaries



along with the venous fibres, I think some failure, &c. will affix a more probable use than is generally attributed to them.

These latter, &c. the venous fibres, run in a longitudinal direction. I have already endeavoured to shew that the arterial exert their influence in resisting the great lateral pressure of the blood, which is beyond all comparison greater than the arterial, insomuch as the lateral surface is of much more extent, than that of the ends of the arteries: reasoning from anatomy, we should suppose that the venous fibres resisted the longitudinal stretching of the veins: this however cannot be since the force in that direction is very small: May they not then have some influence in the moving of the blood? It appears to me more probable, than the oscillatory movement of Pictet.

Dr. Jackson alledged, from microscopical observation, that the minute circulation is not performed in vessels: unless we consider the whole frame, as a series of convoluted vessels, we cannot, without this fact before us, believe in the omnipresence of the fluids: and with it the pathology of disease is intelligible and rational: Yet it is certain that the



various capillaries must have a constrictment, which he thinks it is not de rae. This however, though doubtless correct, is but the connecting link; and without a cause of suction to the various blood, the chain of explanation is far from being complete: whether it be from capillary attraction, or oscillatory movement, muscular contraction, or some other power is yet to be determined. But the rapid march of Science, and the fresh discoveries continually breaking in upon her clouds of Error and Ignorance, lead me to hope, that his with many other unvalued anticipations, will ere long be plucked from among the arcana of Nature, and added to the well earned laurels of Medicine.—

